stone cliffs, somewhat sheltered by brush, grew *Sphenomeris clavata* (L.) Maxon, well named, for the sterile pinnae are wedge-shaped and the fertile club-shaped. *Anemia adiantifolia* (L.) Sw. and *Asplenium dentatum* L. grew in like places.

Polypodium exiguum Hew. and *Adiantum melanoleucum* Willd. grew in shaded places on the limestone cliffs. A peculiar fern ally, suggesting *Gnetum* in appearance, *Psilotum nudum* (L.) Griseb., braved the sun on the open cliffs.

Seed-bearing Ferns.

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The prevailing belief of three centuries ago as regards the mysterious process supposed to surround reproduction in ferns was well voiced by Shakespeare when he says: "We have the receipt of fern seed; we walk invisible."

Now, since the compound microscope and an improved technique has put us in the possession of the intricate details of reproduction and development in the ferns, it is not much to be wondered that it then seemed so shrouded in mystery. But, complicated as the process is known to be, it is only a step in the history of the evolution of the great group of ferns.

Until a few years ago we rested secure in the belief that the dominant types of living plants—the flowering plants—were dominant because they had developed the seed-bearing habit. Within the past dozen years, however, it has been demonstrated that in the oldest land flora of which we have any knowledge, namely, that which lived in early and middle Devonian time, there was a great group of plants, which, while still

retaining the fern-like foliage, had already developed the seed-bearing habit in a high degree of perfection. This group, now known as the Cycadofilices, or better as the Pteridosperms or "seed-bearing ferns," is the subject of this brief note.

Until a few years ago the Paleozoic era used to be called the "Age of Ferns," on account of the obvious dominance of this type of vegetation. While these "ferns," as they were supposed to be, were extremely abundant and exhibited great diversity in form and size, it was always a matter of wonder as to why so few showed the presence of sori. As the vast majority were apparently sterile, these had to be aggregated in "form" genera, or so-called genera of convenience, but always with the hope that some time the fruiting state might be discovered. As we no look back, it is recalled that certain seeds were often found preserved in the same beds with the fern-like foliage, but the idea that there could be any connection between them was unthought of. These seeds were supposed in large part to belong to the Cordiatales, a large group of mostly tree-like plants which show kinship with the living cycads, conifers, and ginkgos.

In 1903, however, Prof. F. W. Oliver announced the astonishing discovery that the little seeds known as *Lygenostoma Lomaxi* were produced by the well-known "fern" from the English Coal Measures known as *Lyginodendron Oldhamium*. This discovery of course stimulated investigation with the result that *Lyginodendron* is probably the most completely known fossil "fern," though it had taken nearly a hundred years, as now turns out, to get the whole story. The foliage was named and described in 1829 under the name of *Sphenopteris Hoeninghausi;* the stem was named in 1866 as *Dadoxylon Oldhamium*, but was transferred to *Lyginodendron* in 1872; the roots, under the name of

Kaloxylon Hookeri, were named in 1876; the petioles as *Rachiopteris aspera* in 1874; the seeds, known as *Lagenostoma Lomaxi*, in 1903; while the pollen-bearing organs, called *Calymmatotheca Stangeri*, were not recognized as belonging to this remarkable plant until 1905.

We are now in position to draw a fairly complete picture of the plant as it must have appeared when living. It was in effect a little tree fern, with long, slender, sometimes branched, stem 4 cm. or less in diameter, and provided with spines by means of which it probably climbed on its neighbors. The foliage was disposed spirally and consisted of relatively very large, finely divided fronds with small, thick pinnules with revolute margins, suggesting a xerophytic or halophytic habitat. The stem in the lower portion gave rise to numbers of slender roots, some of which appear to have been aerial in their origin. These grew downward and often branched where they entered the soil.

The stems, roots, and petioles, and even the pinnules, have been found silicified and so beautifully preserved that their entire structure can be made out with certainty. Without going into a technical description of these organs, it may be said that the stem when young, and before secondary growth has begun has a very strong resemblance to the stem of *Osmunda*, but when more mature certain cycadean characters appear to predominate. The roots when young are marattiaceous in character, but after secondary growth has been inaugurated they assume the well-known character of gymnospermous roots.

The most interesting feature of this plant was, of course, the seeds. Beyond the fact that they were a part of a pinnule, as is shown by the structure of the pedicel, the exact manner of their attachment is not known. The seed itself was a little acorn or barrel-shaped structure about a quarter of an inch long, and

was borne in an open cupule somewhat as is a hazel nut in its involucre. The cupule is studded with capitate glands exactly like those borne by the fronds and stems of *Lyginodendron*.

As already mentioned the seeds are silicified and retain most of their structure so well preserved that almost every part can be studied. The following description is by Dr. D. H. Scott, President of the Linnaean Society of London: "The seed itself is orthotropous and generally of cycadean organization; it shows complete radial symmetry. * * * It consists essentially of a central body or nucellus, enclosed in a seed-coat; these two parts closely united together except at the top. It will be remembered that in modern cycads and in the maiden-hair tree (Ginkgo) there is a hollow chamber in the apex of the nucellus serving to catch the pollen-grains. The same arrangement is present in the seed of *Lyginodendron*, and pollen is still found in the pollen-chamber; the latter, however, is less simple than in living cycads, for a column of tissue rises up in the middle of the chamber, leaving only a narrow space around it for the reception of the pollen. It is interesting to find that the mouth of the pollen-chamber projected a little through the micropyle, so that it received the pollen directly instead of the grains having to traverse the micropyle first."

The last chapter in this fascinating history was the finding of the pollen-bearing or male organs. It appears that on the same fronds which bear the ordinary vegetative leaflets, there are certain fertile pinnules which bear a number of oval discs 2 or 3 mm. in length. On the under side of each disc there are from 4 to 6 two-chambered, spindle-shaped pollen-sacs, and pollen-grains were actually found in them. Until these pollen-bearing organs were found in organic connection with foliage of *Lyginodendron* there was nothing to suggest

that they belonged to seed-bearing plants; in fact, they were supposed to belong to marattiaceous ferns.

The more or less complete life history of a number of other pteridosperms is now known, and from these it appears that there was considerable diversity not only in the form of the seed but in the manner in which it was borne on the plant. Thus, from the Carboniferous (Pottsville beds) of West Virginia, Mr. David White has described a plant under the name of *Aneimites fertilis*, which bore small, winged, rhomboidal seeds on the apices of reduced terminal pinnae. However, lack of space forbids further description of this and other forms.

It is evident from what has preceded that we are not dealing with ferns at all, but veritable seed-plants. It is probable that less than half of the Paleozoic "ferns" will ultimately be shown to be true ferns.

Ferns of the Wissahickon Valley

EDWIN C. JELLETT

(Address delivered at the Philadelphia meeting of the Fern Sociey, December 29, 1914.)

I shall endeavor to speak, not of ferns, but of where ferns grow in the Wissahickon district.

To our local members present Wissahickon Creek is well known, but for the benefit of visitors it may be well to state it is a beautiful, romantic, historic stream, which rises in Montgomery County, Pa., and for 22 miles flows in a general southwesterly direction to the Schuylkill River, with which it unites south of Manayunk. For 16 miles this stream meanders through a picturesque open territory to Chestnut Hill, where it enters a great, tortuous, longitudinal ravine, connect-